Blockchain in Banking

Will a common standard emerge?

Master Thesis

Master of Technology Management (MTM)

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1 Acknowledgement

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2 Executive Summary

From its early start as the technology enabling Bitcoin, Blockchain technology has risen to become a “big thing” within the financial industry. While some dismiss it as being a buzzword or technical jargon, others believe it to have the potential for revolutionizing the financial services industry as we know it today.

Blockchain is on every bank’s strategic agenda, in terms of being *something* they have to address *somehow*. However, few players seem to have a very clear strategy on how to do it and where to start. Maybe because it is difficult to get a grasp on, partly because of the perceived complexity of the technology, and partly because of the wide variety of strategic options it introduces. In this paper, we will try to address the question of where

to start in terms of building an understanding of whether or not certain standards within the technology are likely to emerge, and what this means for players in affected markets. We start by addressing value networks within financial services through a hierarchical approach, and will use theories about dominant designs to analyse how different causal mechanisms affect the development of different standards on different levels of the value network hierarchy.

Through the report we will argue the following:

- Blockchain has proven its value on several use areas through value providing end user applications, but important features are still missing, restraining the industry from acquiring the full benefit from the technology.
- There are technical limitations that needs to be addressed before blockchain technology fully can challenge current financial industry standards on all levels.
- Blockchain for financial services is still in its early stages.
- Dominant designs have the potential to emerge for blockchain platforms, but will probably differ across use areas, industries, and value network levels.
- Incumbent firms are dedicating vast resources into blockchain technology, and with ongoing initiatives they are likely to land on a common industry standard for traditional financial industry processes. However, regulations and causal mechanisms like economies of scale will incentivise disruption from outside the industry, potentially affecting the established industry standard or introducing a co-existing standard.
- Incumbent firms in the financial service industry should approach blockchain technology differently depending on their relative market size and position.

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4 Introduction and Background

Through history, transactions and the surrounding systems and mechanisms have developed drastically. In ancient times, non-financial transactions were commonly conducted through systems of credit, where goods or services were exchanged for a promise of future compensation. Debts could eventually be settled with either goods, money or other substances of agreed value, such as gold or silver. Credit has certain disadvantages, among others the requirement for trust among traders, intermediaries or authorities that can be relied on to enforce agreements. However, the credit system was more common than a system where traders met face to face to complete an entire transaction in a single swap (Graeber 2009).

Together with the establishment of settlements as cities, states and empires, coins and other forms of currencies were established, permitting the accumulation of assets not deteriorating over time as goods might, and with relatively secure backing of governments being able to adjust its value through production control. Such fixed currencies were gradually replaced by floating currencies during the 20th century (Amadeo 2017), and development of computer networks has made electronic money possible, increasing the speed and complexity of financial transactions rapidly (Firpo 2009).

Introduction of new and complex technologies creates opportunities for startups challenging incumbents and their existing business models. It also creates opportunities for consulting companies exploiting little technology knowledge among the strategic leadership and creating a “burning platform” and proposing solutions not necessarily driven by the incumbent’s business strategy and needs. Simultaneously, governments and industry organizations are introducing new regulatory requirements, enforcing banks to make investments and changes again potentially creating new opportunities for challengers without the same technological legacy as the incumbents.

Distributed ledger technologies enable companies to make and verify transactions without a central authority (Norton, 2016), and Blockchain is the distributed ledger technology that has received most attention. It is probably best known for being the underlying technology of the cryptocurrency Bitcoin, one type of digital currency introduced as an alternative to traditional currencies. More than 600 cryptocurrencies are currently available, and in the last couple of years there has been tremendous activity on finding other applicable areas for blockchain technology.

Blockchain is predicted by many to turn banking and financial services upside down from how we know it today, and new firms are entering the market on a daily basis, applying the technology to create new services both vertically within a business, but also horizontally - across traditional industrial borders. The technology is on all the big financial corporations' agenda and has become big business for consulting companies (Accenture, 2016; Infosys, 2016; Ven, 2016). However, understanding what it really is about and the opportunities it provides, appears challenging. The technology is by many compared to how the Internet was in the beginning - difficult to get hold on from a business and user point-of-view because of its inherent boundlessness (Swan, 2015). There exists thousands of articles and presentations aimed at executives and business leaders - however, not until recently these seem to have caught the essence of the strategic implications the technology can have for incumbent businesses[1].

The customer database is the backbone of a bank, developed over years with massive technological legacy to cope with. In its simplest form, the blockchain is just a database. However, it possesses technological attributes that according to some people can change the entire backbone of the traditional banking industry. A new technology

[1] Through the literature search, almost all of our identified sources for the strategic analysis is from late 2015 or newer.

emerging, ready to challenge the heart of the business as we know it today by creating a playground for new ventures with new business models, eager to take a piece of the cake. Will this be an industry gamechanger? Will it become every bank's worst nightmare, or can it be turned into an advantage through new business opportunities also for incumbents in the financial industry?

5 Research Question and Purpose of the Study

Through own experience from strategic management level within the industry, we have learned that incumbents are reluctant to approach blockchain technology due to lack of industry standards. They simply do not know where to start, and do not wish to come in a position where they have started working with a technology showing up to be on the outside of what becomes common standards within the industry. Through this thesis we therefore wish to explore blockchain technology through the strategic lenses of an incumbent Norwegian bank, by addressing the following research question:

Will blockchain standards within the financial services industry emerge?
And if so, what will characterize the standards emerging?

The purpose of the study is to provide fact based insights to the topic, understanding the implications of the research question for a Norwegian bank's strategic agenda, and translate our findings into insights and recommendations.

6 Theoretical Context and Focus

The theoretical context we apply to address our research question is around industry dynamics, dominant designs and value networks. Industry dynamics theory will be used to explain how the introduction of new technologies affect the dynamics of an industry, while dominant designs theory will form basis for addressing the core of the research question: how standards within a technology emerge and what characterize such standards. The value network aspect is brought in to address the industry angle of our research question - in terms of being able to analyze potential emerging standards within the industry, we need to understand how the industry works.

6.1 Industry Dynamics

Agarwal and Gort (Agarwal & Gort, 1996a) draw on earlier research to understand how the introduction of new products or technologies affect the dynamics of an industry, in terms of entries, exits and survival of firms in that certain market. Their paper shows how both entry and exit rates are dependent on the systematically development of the market from birth to maturity. The paper also shows how survival rates are dependent both on stage of development and on individual firm attributes.

The traditional approach to industry dynamics is to look at firms' or products' adjustments to an equilibrium defined by certain market attributes. This can be attributes such as barriers to entry and economies of scale, introduced in Porter's five forces model (Porter, 1979). In the traditional context, the survival probability

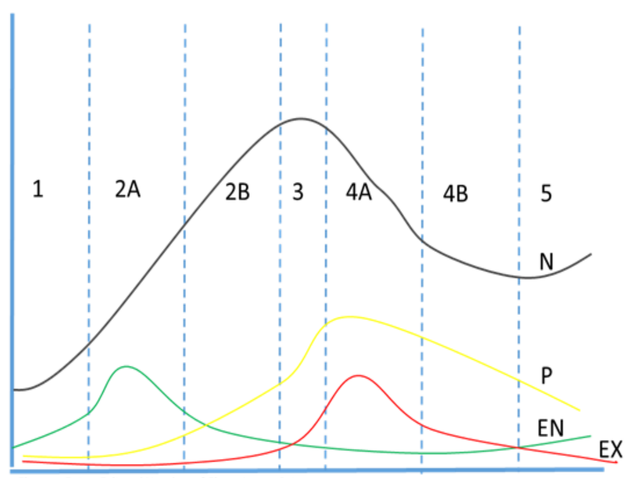


Figure – Entry, Exit and Number of Firms Across Satges
Addition to orginal figure the muber of patents (yellow)

of a firm at a given interval, would thus be a function of a vector of market attributes and a vector of attributes one can relate to the firm. Gort and Klepper (Gort & Klepper, 1982a; Porter, 1979) try to depart from this traditional view by introducing evolutionary development stages of markets, to broaden the explanatory factors for entry, exit and survival.

Their analysis of the stages of a product market can be summarized as follows: The model looks at the average entry (EN) and exit (EX) rates by an aggregation of goods over the full product lifecycle. The model also shows number of firms (N) and number of patents (P). Note that the figure is intended to be illustrative and is not drawn to exact scale. The figure shows that as a market evolves the number of net entrants increases and peaks in 2A, while the market reaches its peak in stage 3. Gross exits remain at low levels until they start rising in the end of stage 2B and reaches its peak in stage 4A. As such, the decline of number of firms in stage 4 is a result of rising exits.

The model implies, in general, a negative relationship between gross exit and entry. Gort and Klepper (Gort & Klepper, 1982a) found that peaks could be found in the rate of technical change in both stage 2 and 4, evidence of a bimodal technical change. In stage 2 the larger proportion of innovation is from external inventors whereas in stage 4 the innovations are more internal. This is in line with Agarwal (1994) showing that patents often peak in stage 4.

Agarwal and Gort (1996) show that the survival rates of firms are dependent on both market and firm attributes. They find that the role of market attributes is related to the stage of the product cycle, and often reflected in rising hazard rates for firms entering in stage 1 and 2. For high-technology products the market attributes contribute to a higher survival rate for entrants.

6.2 Dominant designs

When discussing emergence of blockchain standards, we will base our analysis on theory about dominant designs. The concept of dominant designs was introduced by Utterback and Abernathy in 1975, where the idea is to identify key technological features that makes a technology become a de facto standard (Abernathy, 1978; J. Utterback, 1994). The dominant design is the one that wins the allegiance of the marketplace, so that other players in the market must adhere in order to stay competitive in the market.

Utterback and Abernathy's concept was initially intended for physical attributes. However, through further discussion and research the concept has evolved. Murmann and Frenken introduced a framework based on a systematic review of literature from the concept pioneered by Abernathy and Utterback to the publishing of the study in 2006 (Murmann & Frenken, 2006). In addition to providing a more systematic approach to discussing the emergence of dominant designs, Murmann and Frenken also incorporate in their framework that a dominant design is something that does not only occur for physical things, but can also occur at a more abstract level. We therefore mean that their framework is applicable when discussing the emergence of dominant designs within blockchain technology.

In their article "Toward a systematic framework for research on dominant designs, technological innovations, and industrial change", Murmann and Frenken (2006) emphasize the need for a more cumulative framework around dominant designs, both for grouping historical research, but also to ease the future research on the area. In their efforts to integrate other scientists' empirical observations into an analytical framework, they have organized the different perspectives along six dimensions. Based on the wide range of contributions, they propose a model that applies complex systems theory to technological artifacts. They believe that a complex systems perspective can develop a more systematic understanding of technological design in general and deal explicitly with the six mentioned dimensions of differences. The framework allows for analysis across different dimensions, which we find useful for addressing the complexity in the blockchain concept.

They propose to define “dominant design” as *a set of designs that share the “high-pleiotropy” components of complex technical systems* (Murmann & Frenken, 2006). Their rationale behind this definition is that the high-pleiotropy components of a complex system are difficult to change successfully, hence that *emergence of a widely accepted design with high-pleiotropy components will change the dynamics of design search and competition in the technological class*.

Their aim is to arrive at a clear set of definitions about dominant designs through a model organizing the different perspectives along six dimensions:

Dimension		**Research questions and areas of differences**
1	Definitions of dominant designs	How do we define dominant designs?
2	Unit of analysis	On what levels do we find dominant designs?
3	Granularity (level) of analysis	On what levels are two designs different or the same? (level of detail and granularity of time interval)
4	Temporal sequencing	How do product classes evolve and dominant designs emerge?
5	Causal mechanisms	Why does a particular design approach rather than other ones emerge as the dominant design? Five

		types: a. Best technological compromise b. Economies of scale c. Network externalities d. Strategic maneuvering towards market dominance e. Sociological, political, and organizational dynamics
6	Boundary conditions	How broad can dominant design theories be applied?

They believe that a complex systems perspective can develop a more systematic understanding of technological design in general and deal explicitly with the six mentioned dimensions of differences. Their approach is built on the following six ideas:

- Technology as a complex system
- System, subsystems, and components
- Operational principle
- Core and periphery
- Economies of scope
- Radical and incremental innovations

On the basis of their conceptualization of technology as a complex hierarchical system that is brought about through a search in a nested hierarchy of design spaces, they propose a definition of dominant designs, and how it can be operationalized in the six dimensions:

Dimension		Murmann and Frenken's approach
1	Definitions of dominant designs	A dominant design exists in a technological class when the majority of designs have the same technologies for the high-pleiotropy core components. They suggest how to define dominant designs, where they can be found, and what should be measured.
2	Unit of analysis	A system is a nested hierarchy of subsystems and components, and to specify a unit of analysis, both the level *above* and *below* the focal unit of analysis need to be defined.
3	Granularity (level) of analysis	The granularity adopted in a particular study needs to be specified by identifying what would count as one granularity level finer and what would be one granularity level coarser. To be able to replicate findings, time interval must also be specified.
4	Temporal sequencing	The cyclical nature of technological development proceeds in nested cycles at the respective level of the hierarchy (system, subsystem or component).
5	Causal mechanisms	Mechanisms are expected to differ in their relative importance depending on the nature of the technology, its interface with the users, and the socio-political regime.
6	Boundary conditions	The model applies to complex artifacts, and the authors believe all artifacts to be complex due to numerous relevant design dimensions that interact in complex and unpredictable ways.

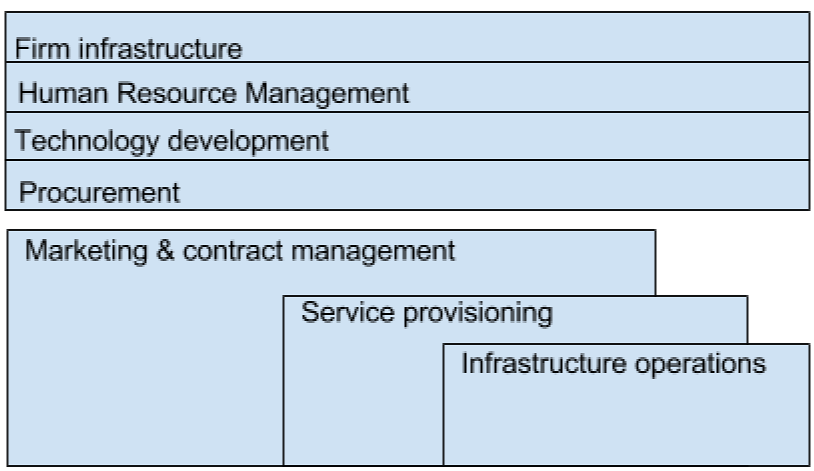
Murmann and Frenken link technological dynamics to organizational outcomes, where they among other things state that:

- Higher-order design developments, as standardization, greatly affect industrial dynamics at lower levels.
- Standardization may trigger entry at lower subsystem level while forcing firms to exit at the system level.
- Firms higher up the hierarchy have a greater control over their life course than those at lower levels of the hierarchy.

We will use Murmann & Frenken's framework to structure and scope our analysis, and also link their generic research findings to translate some of our findings into recommended strategies.

6.3 Value networks

Stabell & Fjeldstad (1998) present "Value networks" as an alternative way of describing value creation to the traditional value chain view (Porter 1985). The idea is that value is created through facilitating connections between customers, and by offering services that improves on these connections. The value networks model shows that the three primary categories overlaps, this is in order to underline the interactivity across the primary activity categories. While the traditional value chain view provides a direction on where value is created, Stabell & Fjeldstad's model has no arrows, points or process that identifies the production process to the final customer. This is to underline that the value creation in the network is formed by mediating between customers.



Stabell & Fjeldstad use the value networks concept to describe organizations such as cell phone providers and retail banks. According to Fjeldstad (2008) organizations over time engage in exploration and utilization. Whereas exploration can be said to contribute to the development of competitive advantages, utilization is when you transform your competitive advantages into results. How explanation is conducted, and the level of balance between exploration and utilization depends on the industry, exogenous conditions and timing. In industries where knowledge is critical, organizations are formed to be both experts in internal R&D and in exploration in cooperation with customers, universities, and competitors in order to secure and develop internal value creation (Powell et al. 1996).

The value of a value network is strongly dependent on network effects connected to existing or potentially relationships between customers (Fjeldstad 2008). The concept of network effect is used when the value of a service or a product is dependent on the size of the of user network or the mix of the customers that use the service or product.
As such you can differentiate between innovations that increase the “connectivity” within a network, meaning who you can connect with using the service or the product.
And innovations that increase “conductivity” meaning what can be exchanged by the service, and other innovations that contribute to increase the willingness to pay for a service or contribute to lower the costs.

Being able to create profit through network investments is strongly connected with investing in technology development and patents (Katz and Shapiro 1985).

7 Method

7.1 Methodological approach

Having presented the background, purpose and theoretical context of the study, we will in the next chapter present our empirical findings. We will start by presenting some industry characteristics to describe the historical change it has gone through, and how the actors in the industry are all connected to each other through different networks. Further, will address how regulations affect competition and innovation in the industry, before drawing on mobile payments as a case example. We will use this case throughout the thesis both because we believe most readers familiarize with it, but also because it demonstrates how regulations have contributed to a cross-industry platform war affecting the value networks within financial services - a platform war where we will argue that blockchain technology has the potential to play an important role.

We will thereafter explain the blockchain technology, starting from a historical perspective, before adding insights into the core features it provide. We will then provide a structured view on what the technology can do. Even though we will not leverage on all the details we present here in our analysis, we will go through the building blocks quite thoroughly. Our further analysis will focus on the technology as a platform, and to understand this concept, we believe it is important to build an understanding of what this means, in terms of what it is built on and what it can do. We will then present some use cases, before we wrap up the chapter with the main weaknesses of the technology.

In our empirical findings we will bring in both literature research from articles, research papers, and acknowledged books and publishings. We have also conducted 14 semi structured interviews, 4 with experts from academia and consulting, and 10 with people from within the industry. The subject matter experts we have interviewed are:

- Harvard Professor Patrick Murck; lawyer and expert on blockchain. He is currently conducting research into the law and policy implications of bitcoin, distributed ledgers and smart contracts.
- MIT Media Lab Senior Advisor Michael J Casey; Blockchain and Cryptocurrency expert.
- Management consultant Jacob Bølgen Bronebakk; CxO experience from financial services in Norway, currently advising on blockchain strategy.
- MIT Sloan professor James Utterback; Technology Management expert, specialized within industry dynamics and dominant designs.

We have used the expert interviews to get qualified views on our empirical findings and the specific research question - opinions difficult to identify through general literature research. Key takeaways from these interviews are perspectives on alternatives to blockchain, weaknesses with the technology, and what they believe to be important for the further development of the technology. While the first three interviewees provided great insights into the the technology, Professor Utterback's input was especially relevant in terms of providing interesting historical aspects on what to address when analyzing the potential for standards emerging within the technology.

The industry interviewees are people on strategic level within various Nordic banks and financial services companies. The main purpose of these interviews was to understand the current knowledge level of blockchain within the industry today, how it is approached from a strategic level, and understand how they assess its potential.

Our analysis will be performed around two main topics: value networks and dominant designs. We see blockchain technology as a potential enabler for alternative value networks linking to inside the industry, and will therefore start by analysing the industry from this theoretical perspective. In this part we will use the rise of mobile payments services as a case example in connection to both the creation of value networks and platforms. We will then summarize our discussions in a framework illustrating how different value networks exist on local to global levels, before we based on insights from our empirical findings do an evaluation of the potential for blockchain technology within value networks on the different hierarchical levels. This framework is not drawn from literature sources, but is our own effort of presenting our findings from the value network analysis in a reader-friendly manner, and can thus be seen as our humble contribution to the research area.

In our dominant design analysis we will argue that the standards race will happen on the platform level, and will throughout the analysis link our findings to the results of our value network analysis. The main part of the analysis will be around the different causal mechanisms for dominant designs, and how this affects the emergence of standards across the presented value network hierarchy.

Finally, we will based on our discussion summarize our findings into final conclusions answering our initial research question.

Throughout the thesis we use the terms blockchain and distributed ledger technology interchangeably, although there is a difference: while blockchain technology builds on distributed ledger technology principles, a distributed ledger does not necessarily have to be a blockchain. Although distributed ledger theory is actually what we really address through the thesis, we will mostly refer to the term blockchain as this is more familiar for our target audience and the technical difference is of no importance for our research question the way we address it. This will be further discussed throughout the thesis.

7.2 Validity of methodology

Our initial plan for the thesis was to use traditional innovation theory to analyze organizations’ ability to implement and capitalize on complex technology innovations such as blockchain. In our early interviews with people inside the industry we learned that we had to reframe this approach. Our interviewees were all more curious on *what* to implement than *how* to implement it. This was why we decided to frame our thesis to address the emergence of standards within blockchain technology. In our opinion, traditional innovation literature does not provide sufficient theoretical foundation to address such a perspective, perhaps demonstrating a lack in the literature when addressing early stage complex technology innovations. To address our specific research question we therefore focused on dominant design literature, but would very much like to see future research focused on what we initially planned to address through innovation literature.

While the concept of central ledgers has been around for centuries with well known proof cases, similar solid proof cases for distributed ledgers are quite few. For a more mature technology our research question might have been framed differently, and the empirical findings more consisting of quantitative data. In our case, given the lack of available proof cases and business cases, the paper relies on more qualitative sources of data to draw on what technology innovation has taught us throughout history, and how this understanding can be used together with insights about the industry we analyze in context of our research question. Our approach has weaknesses in terms of not giving us conclusions possible to present as scientifically tested truths. With a more mature technology a broader research into how users see the potential emerge could also broaden the scope. However, given the maturity level of the technology and the fact that nobody have yet been able to predict dominant designs before they occur (Utterback 2016), we find our approach suitable to answer our research question and provide relevant strategic guidelines.

8 Empirical Findings

8.1 The Financial Services Industry

8.1.1 An industry in change

Ongoing technological development causes big threats for the traditional financial services industry, while also introducing great opportunities. New technology solutions improve workflow and processes, and reduce the need for paper money and human interventions (Bakker, 2016). Financial services companies are attacked from all corners by new Financial Technology (FinTech) startups, grasping technology innovation as an opportunity to disrupt the established industry. It affects almost every financial activity, from banking to payments to wealth management. Startups re-imagine financial services processes, forcing incumbents to innovate to meet competition.

Within the entire space of financial activity we see startups with new business models that challenge the established paradigm. While on one side trying to protect themselves from new entrants and becoming obsolete, the incumbents on the other hand are working on how to benefit from the rise of new digital opportunities to become more competitive within their existing space. Current key trends within the industry listed by (Bakker, 2016) and (Finnegan, 2016) are:

- Banks invest heavily in innovation, but have difficulties diffusing their innovation strategies throughout their organizations. They will have to find a way to develop new platforms while overcoming legacy infrastructure.
- Startups try to navigate the regulatory landscape, and will have to find a way to scale out their business while facing increased regulations, higher costs, and larger infrastructures that will be more difficult to change and manage.

- Technology giants like Apple, Google, Facebook, Amazon and Samsung put increased pressure on traditional banks, and are expected to build on their consumer relationships to expand within the payments area.
- Blockchain is seen as a wild card with potential for completely overhauling the industry. Both major banks and startups around the world are experimenting with the technology to see how it potentially can lower the cost of different business verticals substantially, which currently face high operating costs. It can also disintermediate many financial processes heavily relying on third parties today.

With regards to innovation investments and organizational transformation, our interviews confirm Bakker and Finnigan's findings. Our perception through interviews with industry experts is that the industry is following threats and opportunities arising from new technology, products and services closely. Most of the banks have dedicated persons monitoring and advising with respect to these issues holding positions on management level. Common for all of the industry interviews was the interviewees demonstrating a decent basic understanding of the blockchain concept, and a fair knowledge of the potential it represents. However, it seemed quite superficial and characterized by addressing the big trends and views presented in early research papers and media coverage. When asked about how technology innovation initiatives are structured and organized within the organization, most of them answered that they had some kind of digital innovation team organized to realize initiatives, but that interfaces with legacy IT was a big hurdle to overcome.

Banking has been through several rounds of disruptive changes, and the number of banks has reduced greatly the last decades. This has also reduced the banks' qualitative knowledge about their own customers, and today banks are relying more on pure quantitative knowledge (Campanella, Del Giudice, & Peruta, 2013). This has again lowered customers switching costs, since every bank has similar information about their customer and thus have similar risk profiles.

The threat of branchless banking has been the most direct threat to incumbent banks in the last few years. Banks such as Skandiabanken in Norway have no traditional branches, and no “face” meeting the customer. The only interface is using their services through the web portal of the bank. Since they are using the same quantitative data as the traditional banks, they can operate with lower transaction costs and consumer prices. Branchless banking was a new business model, that arrived due to the implementation of services that were fully automated, such as ATMs, phone banking and later online banking (Campanella, Del Giudice, & Peruta, 2013).

According to recent Accenture research on retail banking (Accenture 2015), banks are at risk from losing more than 30 percent of their revenues to outside firms. Customers are now more digital native and as such expect their banks to keep up with the technology development. They expect the bank to be a facilitator of various high quality services instead of specific financial products. To face this ever rapidly changing landscape with expectations from customers and regulatory demands, banks need to become more agile and adapt to a more consumer centric strategy (Accenture 2016).

Accenture also find a shift in the way that banks look at the competition from FinTech companies (Accenture 2016), where the traditional competition is shifting towards co-opetition with mutual benefits. Banks are now partnering up with FinTechs to provide better products and services faster, and also to target new customer groups. The Fintech companies on their side realize their need of the banks’ infrastructure and long term knowledge within risk, compliance and financial regulations.

8.1.2 An industry of trust networks

Traditional trust networks within the industry have a high degree of control and trust in a single actor or in a small network of actors. An example is the SWIFT network which governs a network of individually linked trusting banks that can initiate international transfers with reduced risk and transaction time between intermediates. SWIFT is governed as a web of trust, so that two banks in the network can always be connected trustworthy to each other through the network (Wikipedia contributors 2017).

When asked about when they potentially would start experimenting with blockchain technology, the interviewees from the industry essentially responded that they could not see the value blockchain would give them until the industry would agree on a common standard. Many pointed to the fact that Nets, the existing trust network for payments within Norway, is one of the most cost efficient payment systems worldwide. Norges Bank also states that the Norwegian payment system is efficient in comparison with other countries (Norges Bank, 2012).

«I believe blockchain based innovations will be introduced by entrants from outside the existing industry. For us, it is crucial to build the right partnerships with such actors, as they will be driving the game-changing innovation in our industry.» - Industry interviewee

Some interviewees explain their passive approach with them in general pursuing a fast follower strategy for technology innovation. Others point out the uncertainty of which standard to pursue, and whether blockchain at all is the right technology to address their challenges. Some of them also address the overall industry reluctance with the fear of cannibalization on existing revenue streams from established networks like Nets and SWIFT, where they have made direct or indirect investments over years.

"The fear of cannibalization on existing revenue streams is a big hinder for real innovation like blockchain within the industry today." - Industry interviewee

However, when asked about where they first expect to see blockchain disrupting existing business models, most of them reply payments services, and especially international money transfer. This was not a very surprising finding, being in line with early publications, and also supported by the current use cases we see gaining terrain and success within this marketplace.

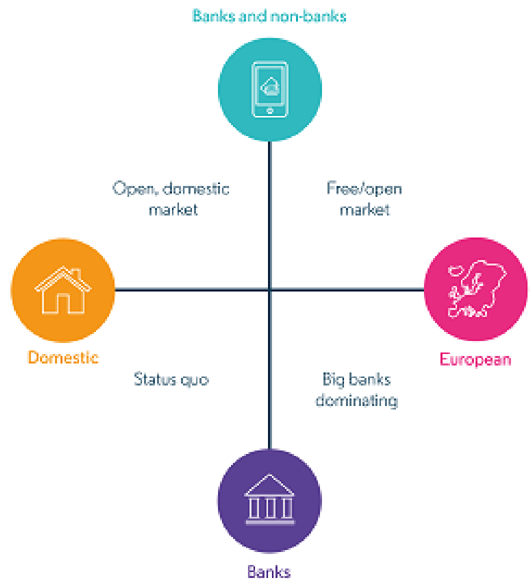
8.1.3 Industrial regulations as enabler for innovation

Regulatory barriers are a two-edged sword - they create a cost barrier for new entrants to the network, while also creating arenas for innovation both from outside and inside the industry. Pelkmans & Renda (2014) describe how regulation has shown to improve the speed of innovation - including disruptive innovation - arguing that the amount of regulation and regulatory changes can indicate the degree of innovative disruption an industry is likely to face.

According to Deloitte (2016) all Fintech firms in the future may be subject to regulations and other safety and soundness requirements as a result of their relationships with banks. One key aspect in the financial regulatory industry is the concept of *knowing your customer*, also known as the KYC process. From a regulatory point of view, a core question when services and products are being merged across industrial borders is how to ensure equal requirements among the different actors.

PSD2 is an expansion of the Payment Services Directive (PSD), aimed to increase industry competition by allowing new players, also non-banks, to access each other's customer information. The directive will be introduced on January 13 2018 (Finans Norge 2017), and will introduce an era where banks will not only be competing against other banks, but with all actors interested in providing services based on each other's customer information (Evry 2016).

The figure shows four possible scenarios for how the PSD2 directive might change the payment service landscape illustrated across two variables (Evry 2016), one being how open the market is to purchasing or using services outside their domestic market, and the other how open it is to incumbent non-banks and FinTechs to handle their financial transactions.



Hypothetically, if the concept of the directive is stretched far enough, the industry can reach a state where it does not matter who “owns” the customer, since all players can access the same information about the customer - no matter who actually has it stored. This moves the competition from winning customers to providing the best platform for any customer - no matter where that customer may have his or her relation today.

8.1.4 Recent industry innovation case: Mobile payments platforms

The Nordic market was one of the first to take mobile wallets into use for real time money transfers and payments. The major banks and banking groups in the Norwegian market all started to work on their own solutions. After early agreements on using Nets as a common platform allowing all the solutions to interact, DNB chose to launch their own Vipps app. This was in the first stage based on VISA payments, with an initial seemingly low fee of 1 NOK per transaction. When Danske Bank launched their MobilePay platform free of charge, Vipps followed (Wikipedia contributors 2016).

In addition to these main platforms, SpareBank 1 purchased MCash and the EIKA alliance launched their own app Snapcash - only working for transactions within the alliance. With global players such as Google and Facebook applying for European money payment licence (Forbes 2014), the banks realize that the competition within payments will not only be fought on a national level. Both Vipps and MobilePay openly invited other banks to join in on their platforms. This resulted in over 100 banks, including SpareBank 1 and Eika, joining Vipps (Nettavisen 2017), openly recognizing the global players as their biggest common threat, along with need for standardization. The most recent innovation on the Vipps platform was the launch of VippsGO on May 4 2017, extending the services on the platform to in-store payments (Nordstrøm 2017).

Our industry expert interviewees described how the mobile payments battle has evolved into becoming a battle of establishing the best PSD2 platform, although initially not having a other intentions than providing high quality mobile customer services. The positioning among the actors is now to a large extent about winning customers on their platform in order to capitalize on other banks' customers when PSD2 is introduced and banks have to share with each other what up till now has been considered their most valuable asset: the customer information. The banks' biggest fear is the payments market entrance of technology giants like Apple, Google, Facebook, Amazon and Samsung, and is by our expert interviewees considered the greatest reason why we see the Norwegian and Nordic market going towards a payments platform consolidation - to stand stronger together when the big giants attacks from outside the industry.

8.2 The building blocks of Blockchain technology

8.2.1 The origin of the technology

Work on cryptographically secured chain of blocks can be traced back to 1991 (Konst, 2000), and in 1998 the first work on a mechanism for a decentralized digital currency called *bit gold* was conducted (Popper, 2015). The first blockchain was first implemented by Satoshi Nakamoto in 2009, and was introduced as a core component of the digital currency bitcoin, where it serves as the public ledger for all transactions (Davis, 2011; Economist Staff, 2015; Nakamoto, 2008). The Bitcoin technology is based on a combination of earlier work on HashCash (Back, 1997), combined with a decentralized timestamp mechanism to control the order of transactions. The blockchain made bitcoin the first digital currency to solve the *double spending*[2] problem, and its design has been the inspiration for other applications - among them several blockchain based (Economist Staff, 2015; Popper, 2016).

8.2.2 The Blockchain Database

A blockchain can be compared to a container space: Anyone can verify that the container is there, because of the label on the outside, but only the owner of the individual container can unlock it and see what is on the inside, because only he or she holds the private key to it (Mougayar, 2014). The blockchain behaves like a normal database, but unlike the traditional database only the “header” is public while the content is kept private through cryptography. Using conventional banking as an analogy, the blockchain can be seen as the full history of banking transactions where the blocks are the individual bank statements (Prableen Bajpai, 2014).

In its simplest terms, the blockchain is a distributed database - more precisely, a distributed ledger. It uses a decentralized, mathematically encrypted network of computer nodes to verify and record transactions (Wilson, 2015). It can be used to record any transaction in real time, allowing for an immutable audit trail of all transactions. The transactions are verified by members of the network - the principle referred to as *distributed (or decentral) consensus (Manuel & Andrews, 2016)*). This mechanism, together with *a network of computers* and *a network protocol*, is considered the three main components of the blockchain (Norton, 2016). The role of the computer network is to maintain the ledger’s consistency and securing reliability even though one node on the network goes down, and the network protocol governs the communication between the nodes on the network. The blockchain uses cryptography, allowing each network participant to manipulate the ledger in a secure way, without the need for a central authority (Norton, 2016). Anyone can use blockchain technology to store

[2] Double-spending is a failure mode of digital cash schemes, when it is possible to spend a single digital token twice. Traditionally, this requires a neutral third party to verify whether a token has been spent or not.

transaction information, and the distributed consensus mechanism and cryptography provide required trust for the user - to a large extent eliminating the need for intermediary, thus reducing risk of human error.

8.2.3 Decentralized consensus

The problem that blockchain intends to solve is the Byzantine Generals Problem when it comes to transaction of value. The problem is described by Lamport, Shostak, & Pease (1982) as such:

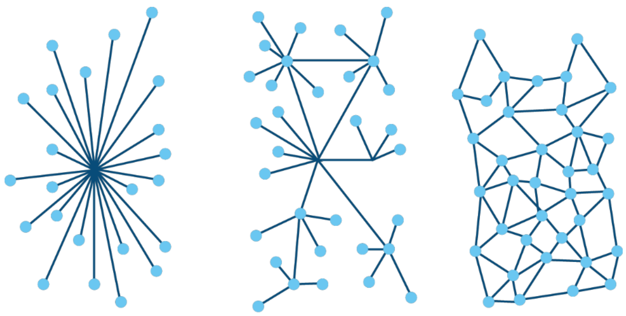
”We imagine that several divisions of the Byzantine army are camped outside an enemy city, each division commanded by its own general. The generals can communicate with one another only by messenger. After observing the enemy, they must decide upon a common plan of action. However, some of the generals may be traitors, trying to prevent the loyal generals from reaching agreement. The generals must have an algorithm to guarantee that
A. All loyal generals decide upon the same plan of action.
B. A small number of traitors cannot cause the loyal generals to adopt a bad plan.”[3]

The Byzantine Generals Problem introduces the concept of decentralized consensus (or distributed consensus), recognized as a key tenet of the crypto-based computing revolution (Mougayar, 2014).

There are several ways of achieving consensus of what information is considered the most updated version of a database in a network. The traditional way is by having a centralized master/slave system where a single master is always referred to as being the authority. There are decentralized variants of this that may contain multiple masters

[3]Note that there is no common plan upfront. Who comes up with the plan or the details of the plan is not essential, rather that the generals know that there is a single plan everyone agrees to follow. Secrecy of the plan is not important - the generals do not care that the traitorous generals know what the chosen plan is.

or that has a hierarchy of authority, but they usually end up having a requirement on either a single or a small group of nodes as the authority.



Distributed consensus through distributed ledger technology is about turning this principle inside-out by not having a master to query about the truth, but instead to let the contents of the database to be decided through distributed consensus. The goal of a distributed consensus algorithm in a distributed ledger network is to let many different users agree on the current state of the ledger even though they don't trust each other or any central authority (Ethereum contributors, 2016). This has been seen as a challenging problem for distributed ledger technology, and the Bitcoin network was the first to solve it.

Distributed consensus of the database is made by enabling its nodes to continuously and sequentially record transactions on a public “block”, creating a unique “chain” - the blockchain (Mougayar, 2014). Transactions are recorded on a block - a record in the database. Once the block is full, the process of creating a new block begins. The next block is created by “miners” who create a “hash” (a unique fingerprint) of the previous block, the transactions on the current block, and a “nonce” (a random number). In order to be accepted as the next block , the new hash has to contain a given number which can only be found by calculating a large number of hashes (Bitcoin Contributors 2016; Bronebakk 2016). This way, the combination of distributed ledger technology and cryptography together ensures that there is no duplicate recording of the same transaction in the database.

Consensus can be seen as the bottom layer of a decentralized architecture, forming the basis for the underlying protocol governing the operations of a blockchain (Mougayar, 2014).

8.2.4 Public and private blockchains

In a public blockchain the information in the database is open to the public, and it is possible for anyone to join the network and make valid transactions. To ensure that the network is decentralized and that enough mining is performed to make the network secure, incentives for mining is given. In the case of Bitcoin this is a fixed sum per block, in addition to a transaction fee that is added by the initiator of each transaction (Nakamoto, 2008).

In a private blockchain, the actors that can initiate transactions in the blockchain are all known and part of a closed network. This allows the actors to have full control over the ledger. The contents of the network can be secret or public - the latter making it possible with a ledger that should be open to the public for inspection, while closed for changes.

One of the the advantages of a private blockchain is that the protocol is easier to change, since it is only the closed network that needs to agree on the change in rules. Equivalently, it is hard to change the settings of a public blockchain after it is first introduced, since everyone in the network has to agree on any changes that are not backwards compatible. This is currently a serious issue for Bitcoin, where the long block time (10 mins) and small block size (1MB) limits the number of transactions that can be performed per block. There has to be agreement between most of the miners to make any change to the protocol, since changes that breaks with current rules would have the network invalidate new blocks and split the chain into several separate chains.

8.2.5 Consensus governance mechanisms

The security of the Bitcoin blockchain is governed by *Proof-of-Work*. This means that blocks are selected randomly, and the harder someone tries to solve the hashing problem, the higher the chance of them being able the select which transactions that will be included in the next block. In practice, Bayes' Theorem[4] and the laws of Thermodynamics are used to prove that a given block has indeed required a certain amount of work to be mined - letting the users pick the longest valid chain with the highest amount of work as the correct chain (Ethereum contributors, 2016). An implication is that it is extremely inefficient in terms of energy. Gimein (2013) estimates the electricity costs of Bitcoin mining to exceed 147,000 USD per day, a cost which is shared by the users of the network through the devaluation of Bitcoin over time as well as transaction fees. This incentivize miners to centralize the hashing power - obviously not aligned with minimizing the need for third parties.

An alternative consensus mechanism is *Proof-of-Stake* (S. King & Nadal, 2012). This mechanism isn't about mining - but about validating - and selection of blocks are specified by the ownership of the backing cryptocurrency in the system. Each validator uses his stake in the chain as a collateral to vouch for a block. In Proof-of-Work you know a chain is valid because there is a lot of work behind it, while in Proof-of-Stake you trust the chain with the highest collateral (Ethereum contributors, 2016). The negative about this solution is that it opens the system up for speculative selection of which transactions goes into a block. Due to this problem, systems that use "Proof-of-Stake" actually often use a combination of "Proof-of-Stake" and "Proof-of-Work" (S. King & Nadal, 2012). Due to the reduction of expensive mining, "Proof-of-Stake" or a hybrid variant is normally used for private blockchains.

[4] A theorem describing how the conditional probability of each of a set of possible causes for a given observed outcome can be computed from knowledge of the probability of each cause and the conditional probability of the outcome of each cause.

8.3 What can Blockchain technology be used for?

8.3.1 When should blockchain be considered?

Wilson and Sutter compare blockchain to hot-sauce: “it works great with the right dishes, but doesn’t go very well with cake” - in other words: it is not the solution for everything (Wilson, 2016). Capgemini Consulting (2016) gives a more precise approach to when it should be considered using distributed ledger technologies:

1. There is some transferring of values
2. Doing the process in or close to real-time adds value
3. There is an existing trustless environment, dependent on neutral third parties
4. The existing solution for solving the problem is considered inefficient

They argue that all of these criteria should be met if a distributed ledger solution is to be considered - otherwise there probably exists more appropriate alternatives.

8.3.2 Decentralized Applications

Blockchain for the broader public has had a slow start. The launch of Bitcoin in 2009 is seen as the first example of successfully building scalable decentralized apps (abbreviated “Dapps”), and is by the authors compared with the internet take-off in 1995 (Johnston et al., 2013). Bitcoin was open-sourced, had a peer-to-peer approach, and was built upon a cryptographically stored record. In the last years there have been many newcomers adapting the Bitcoin model, among the most successful being Ether and Omni. Even though there are technical differences between the platforms, they are alike in terms of building on the principles of decentralized apps. Whereas Omni run on the existing Bitcoin blockchain, Ether uses its own blockchain, the Ethereum blockchain, and they all use different algorithms for reaching consensus on the blockchain.

For an application to be considered as a decentralized application, it needs to meet a set of criterias (Johnston et al., 2013):

1. The application must be completely open-source, it must operate autonomously, and with no entity controlling the majority of its tokens. The application may adapt its protocol in response to proposed improvements and market feedback, but all changes must be decided by consensus of its users.

2. The application's data and records of operation must be cryptographically stored in a public, decentralized blockchain in order to avoid any central points of failure.

3. The application must use a cryptographic token (bitcoin or a token native to its system) which is necessary for access to the application, and any contribution of value from miners and farmers should be rewarded in the application’s tokens.

4. The application must generate tokens according to a standard cryptographic algorithm acting as a proof of the value nodes are contributing to the application.

In the next couple of years, Dapps is expected to become more common as more and more developers and major IT corporations are incorporating blockchain technology into their framework. Following, Johnston et al. (2013) expect that we will see a more comprehensive development that will support a broad range of value-adding components and capabilities on top of the blockchain technology. Already, we see Dapps aimed towards the end user, such as the Mist browser by the Ethereum project (Ethereum, 2014). Such releases are expected to raise knowledge of the use of smart contracts for end users, reinforcing further innovations on the area.

Different blockchains exists for different use areas. Some of these can and will coexist, some fulfill each other, and some will be direct competitors (Mougayar, 2015). Mougayar describes four emerging segments for Dapps from an end-user view, where creation complexity and delivery timeframe increases between segments (Currency lowest):

Segment	Examples	Potential
Currency	Transfers Payments Tips Crowdfunding	Billions of users
Pegged Services	Naming Identity Ownership Membership Voting	Hundreds of thousands
Smart Contracts	Wagers Bounties Family trusts Performance proofs Escrow	Millions of use cases
Decentralized Autonomous Organizations	Transportation Online Storage Mesh Networks Healthcare	Thousands

8.3.3 Smart Contracts

Mougayar (Mougayar, 2014) describes smart contracts as the building blocks for decentralized applications. Smart contracts are small computer programs that can automatically execute the terms of a contract. They are stored on the blockchain, and because they are practically controlled by nobody, they can in theory be trusted by everyone (Bronebakk, 2016; Mougayar, 2014).

The idea behind smart contracts is that the contractual governance of a transaction can be verified through the blockchain rather than through third parties. Instead of having third parties governing transactions between two or more parties, the parties define and agree on the rules themselves, and embed them inside the transactions. Elements of a smart contract are referred to as *"smart properties"* - assets whose ownership is controlled via the blockchain, so that the asset knows who its owner is.

When combining the concepts of the blockchain, decentralized consensus and smart contracts, you enable trust directly between different peers at a deeper level. This reduces the necessity of central organizations as trusted authorities, as many of their central functions can be codified via smart contracts and governed by the decentralized consensus on a blockchain. In not too distant future, we will probably see smart contracts and smart property being created or executed between consenting parties, without either parts knowing that blockchain was the trusted intermediary. This concept is referred to as trusted computing (Mougayar, 2014).

8.3.4 Potential and adoption within banking

In the book "Blockchain: Blueprint for a New Economy", Melanie Swan (Swan, 2015) introduces the concept of Blockchain 1.0, 2.0 and 3.0 to frame the different kinds of current and potential activities introduced by Blockchain:

Blockchain 1.0: Currency	The deployment of cryptocurrencies in applications related to cash, such as currency transfer, remittance, and digital payment systems.
Blockchain 2.0: Contracts	The entire slate of economic, market, and financial applications using the blockchain that are more extensive than simple cash transactions: stocks, bonds, futures, loans, mortgages, titles, smart property, and smart contracts.
Blockchain 3.0:	Applications beyond currency, finance and markets - particularly in

Applications	the areas of government, health, science, literacy, culture, and art.

Blockchain 1.0 is considered quite mature, and the current focus is shifted to Blockchain 2.0 and smart contracts. In terms of concrete solutions for end users introduced by banks, the maturity on this level seems quite low. First when Blockchain 2.0 is starting to mature, it is expected that we really can see the potential of the technology, with the applications introduced by Blockchain 3.0 (Swan, 2015).

What is considered one of the most significant benefits of the blockchain is that it makes it possible to eliminate inefficiencies by making transactions faster and at a lower cost, while also providing increased liquidity, transparency and security (Manuel & Andrews, 2016). The most commonly used example is trades traditionally being verified by a central clearinghouse maintaining its own central ledger. Settling a transaction using this process is costly, and may take up to several days. Companies within the financial services industry are therefore currently experimenting with blockchain technology, in order to minimize the need for intermediary, thus increasing speed, and reducing costs and risk of fraud (Norton, 2016). This is on the agenda of governmental authorities, and the European Central Bank, Bank of England, and Bankenes Standardiseringskontor in Norway, are all examples on governmental institutions working on roadmaps for their respective areas (Bronebakk 2016).

International payments and interbank transactions are areas within banking where we see a large interest, and examples are the initiatives represented by Ripple, SWIFT, R3 and Hyperledger. The R3 Consortium and Hyperledger are examples on global initiatives for ledgers designed to support global business transactions. While the R3 Consortium is driven in a collaboration between the world’s leading banks (Wikipedia contributors, 2016c), Hyperledger is an open source platform (Wikipedia contributors, 2016b). Ripple is an example of a blockchain based global payments network experiencing great success, recently having 12 members of the R3 consortium running their solution as a pilot (del Castillo, 2016). SWIFT is the current standard for international payments, and a good illustration of the potential that lies in the Blockchain for international payments is the fact that SWIFT recently has initiated a proof-of-concept based on the Eris platform. These initiatives receive great attention both because of their impact, but also because they address areas where blockchain or similar technologies might have the potential to realize large cost savings, both for the banks and the end users (J. B. Bronebakk, 2016a).

The blockchain also allows for tracking assets throughout entire supply chains, for example tracking money flow in real time, enabling the user to react immediately on live information, paving way for opportunities for predictive analysis aimed at tightening accounting processes, improving policy-making, and improving treasury management. The distributed consensus mechanism minimizes risk for employee theft and fraud, since the ledger cannot be altered by a single individual because of its distributed nature. Discrepancies are identified immediately, and the source of fraud traced down to its root (Wilson, 2015).

“Blockchain don't need to solve all problems to become revolutionary. It just needs to solve one very important problem.” - Blockchain expert, Prof. Patrick Murck

Below are some concrete use cases on where blockchain technology is considered an enabler for new business models within financial services:

Foreign exchange

The usage of foreign exchange through a service like Ripple (Ripple, 2016a) allows for a much more streamlined clearing process potentially performed almost immediately and with improved service quality for the customer.

International bank-to-bank transfer

Bank-to-bank transfer is today an expensive operation for bank customers, forming a good basis for an attractive use case for utilizing blockchain technology.

Value transactions to/from cryptocurrency

This would involve support for easily transferring money from a bank account to a cryptocurrency like Bitcoin. The inverse support would be to allow for transferring the value of a cryptocurrency directly into a bank account.

Being a trusted third-party for smart contracts

Some smart contracts (OpenBazaar, 2016) depend on a third party to be a neutral mediator in the case of disputes. Banks can take such a position as a dispute mediator by using its current neutral party status combined with their customer knowledge.

Letter of Credit

In the traditional process, banks act as neutral intermediates between parts when buying a set of goods where the buyer is not located at the same place as the goods. The purpose of the process is to guarantee that the buyer will receive the goods before the seller receives the payment for the goods. Using smart contracts, one could reduce the involvement of the banks by introducing criteria like for example that the payment is to be issued when the goods reaches a certain destination between the seller and the buyer (J. B. Bronebakk, 2016b).

Real estate transactions

The process is often mentioned as suitable for blockchain technology, due to a high degree of involvement from different parties: the estate agency for facilitating the transaction, the bank for issuing guarantees, loans and taking security interest in the property for the buyer, while renouncing the security interest for the seller, and public authorities for making changes to the public records. The idea is that smart contracts on can be used to reduce the third party involvement, for example by automatically renouncing and making security interests for the property at the bank and changing the public real estate records when the payment is made for the real estate transfer.

Loan syndication

Loan syndication is usually practiced when the borrower requires a large sum of capital that may be too much for a single borrower to provide. Two or more banks can then together provide the loan, introducing a quite complex regime under today's practices. The idea is to regulate all the covenants and actions on a blockchain using smart contracts, thus reducing the complex governance of loan syndication.

8.4 Weaknesses of the Blockchain

Several weaknesses with the Blockchain technology have been pointed out, some of them challenging the limitations of the concept and its actual potential for disrupting business models. Others are more focused on flaws and weaknesses with the technology itself. Not surprisingly, our interviews showed a divergence between the industry experts most interested in the limitations of the concept, and the technology experts more focused on the flaws of the technology.

8.4.1 The technology simply not being good enough

Two of the academic expert interviewees were sceptic to whether blockchain technology in its current state actually can cover all that is expected from it. They pointed to history showing that technology innovation happens incrementally, and that the first concept is rarely the one to establish as the final concept. Their view was that distributed ledger technology might have a good future, but that something better than blockchain will develop, without the technical limitations the current technology demonstrates.

8.4.2 Possibility of attacks

The possibility of attacks is a constant threat to all banks and financial services institutions (Rizzo et al., 2015). Due to the possibility of multiple versions of a blockchain existing at the same time, a transaction is not considered done until a certain number of blocks has been mined after the block with the transaction. Since the “vote” in the distributed consensus is based on the computing power that is used for mining, it is possible for an actor with an extreme amount of computing power to create an alternate branch that can reverse transactions that has been transacted in the network.

This vulnerability is termed the “51% attack”, due to the requirement of controlling more than half of the computing power on the network to be able to perform the attack. However, the likelihood for this is seen as small in comparison to traditional hacker attacks on banks and other financial services institutions (Floyd 2016).

8.4.3 Reduced privacy

A current issue with the transparency upon which the blockchain is built is the issue of privacy. Banks and other financial institutions are often by regulatory requirements enforced to uphold the privacy of their clients towards other financial institutions. Today, every transaction done on the Bitcoin blockchain is available for all to see. Already there is work undertaken to enable privacy. One such project is the MIT Enigma project (Zyskind, Nathan, & Pentland, 2015)

8.4.4 Clearing time

The discussion about clearing time has risen in connection with Bitcoin’s blockchain, which on average writes a new block every 10 minutes, with recommendations to wait several blocks later to lower the chances of a double-spending attack (Rizzo, Weinstein, Higgins, & Harper, 2015). This validation time is part of the Bitcoin protocol that regulates the proof of work. For incumbent firms in the transaction segment, like credit card companies, such transactions on average take only a couple of seconds to be confirmed, and for the end user the long clearing time is considered a weakened customer experience compared to existing market solutions.

This was also addressed by our industry interviewees, stating that blockchain will not stand a chance against the established payments platforms until it can compete with their performance - simply because customers expect it, and are not willing to change to a poorer performing service provider for a service most people don't pay for today.

8.4.5 Scalability

Transaction capacity though the blockchain has been pointed out to be a challenge in scaling up to the level seen by international transactions today. Bitcoin has a restricted capacity to handle 7 transactions per second, far less than what we see produced by global transaction firms like VISA who has a capacity of 56.000 transactions per second in the US alone (Visa, 2015). Blockchain platforms like Byzantine and Ripple are more directed against financial institutions for cross-border transactions and big volumes.

8.4.6 Quantum computing crippling the Blockchain foundation

Computer scientists are warning that the arrival of ultra-powerful quantum computing machines will cripple current encryption methods and as a result bring Blockchain technology to an end, collapsing the technological foundation it is built upon (Cuthbertson, 2016). The algorithms behind the Blockchain cryptography are designed so that it is easy to calculate in one direction but hard to calculate in the other direction. Quantum computing will be so sophisticated that it will be able to calculate the other direction too, deciphering the underlying cryptography behind the technology, thus opening access to everything available on the blockchain. (Jorgensen, 2016). However, some argue that introducing such a future threat is comparable to judging the internet in 1995 based on what it has become today and what that requires the protocol to handle (B. King, 2016). What there is agreement upon however, is that there needs to be incorporated new quantum cryptography standards into the Blockchain protocol, preparing for this threat.

9 Discussion and Theoretical Analysis

9.1 Value networks in the banking industry

We will start the analysis by introducing the value network view in context of the financial services industry, and how this is driven by industry innovation, digitalization and customer demands. We will then go through a case example demonstrating how regulations and digitalization disrupt the industry by introducing completely new ways of thinking value networks, before we introduce the blockchain concept as a potential enabler for such disruptions. Finally, we will summarize our discussions in a framework illustrating how different value networks exist for different hierarchical levels, before we based on insights from our empirical findings do an evaluation of the potential for blockchain technology within value networks on the different hierarchical levels.

9.1.1 From value chains to value networks

Being gatekeepers to efficient payment services, the banks have a steady stream of customers finding their way to the the banks' websites and branches. This allows for customers buying additional services that the bank offers, such as mortgages, insurance, investment, etc. - making a non-profitable position as a provider of free payments services potentially turning profitable. Even if banks do not earn profits on payments as a stand-alone end customer service, it is in an important arena to win customers in order to generate traffic on other products and services. This is consistent to how Stabell and Fjeldstad present the mechanisms of a value network.

Our empirical findings show how customers view their banks as value networks, expecting them to act as a gateway to different networks of high quality services. Further that there is an ongoing shift in the market where banks move from considering new entrants as a competitive threat to seeing them as an opportunity through co-opetition. This is an example of what Fjeldstad refers to as *exploration*, development of competitive advantages, and shows that banks as a way of meeting the demands of their customers seek to facilitate high quality services through value networks.

The mobile payments case illustrates how banks the last years have been through a strategic journey, from initially competing to provide the best digital services, to now battling on providing the best platform as basis for a variety of services. The case illustrates how regulatives like PSD2 have forced the industry from being inward looking and product oriented to becoming open, innovative and customer centric. The result is a value network strategy where the bank strives to offer the best platform with high quality services performed either by the bank itself or strategic partners. This is an example of what Fjeldstad refers to as *conductivity*, innovations contributing to increase willingness to pay or reducing costs.

The launch of VippsGO is an example of what Fjeldstad refers to as *utilization*, where competitive advantages gained through the platform is transformed into results, in this case revenues from stores offering VippsGO payments services towards customers.

The mobile payments case also illustrates how local and national banks in such a rapid changing business environment to a much bigger extent than before also need to consider global threats when evaluating own strategic options. The entrance from technology giants like Apple, Google, Facebook, Amazon and Samsung will introduce new value networks within the payments services business, where they are able to bundle financial services in a completely new way than we have seen up till now. This is an example of what Fjeldstad refers to as *connectivity* within a network, meaning how the networks allows establishing of connections through its services and products.

9.1.2 Blockchain technology as platform for alternative value networks

Blockchain technology needs to climb one big hurdle when entering the payments industry: a well established network organized through defined industry standards. A distributed ledger network has an advantage over the traditional one, that it reduces risk and costs of transferring between its members. However, a distributed ledger network needs to prove itself worthy as an alternative - not an easy task when the existing network provides proven quality at low or even no end customer cost or risk.

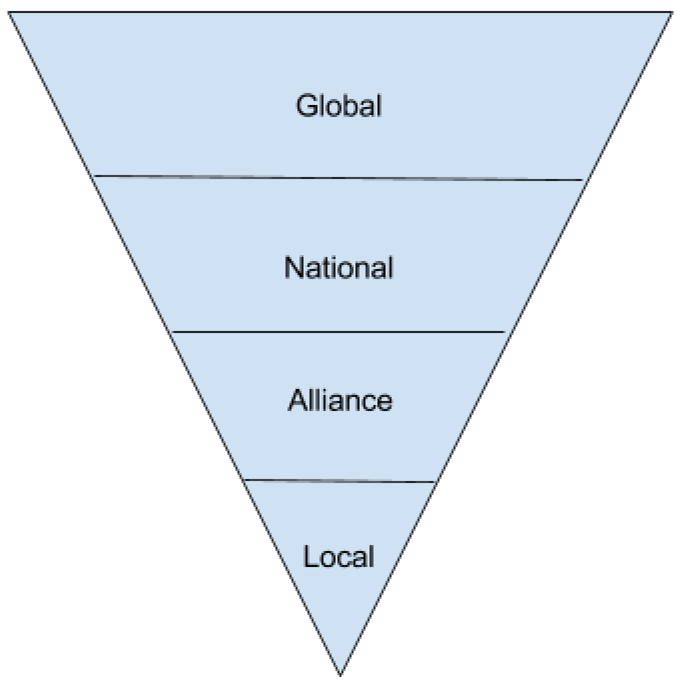
An alternative value network needs to build an end user base, and in order to manage that, enough end users need to see incentives for themselves in taking part of the value network. The largest incentives are probably found where the current network doesn't meet end user requirements. A good example is within Bitcoin, having international transactions as one of its largest use areas, probably because the traditional alternatives are considered expensive and slow. Another example is the high Bitcoin adoption as currency in less developed economies, due to the existing networks not being trustworthy or not having sufficient infrastructure - introducing cryptocurrencies as a strong alternative to traditional government-backed currencies.

This was also pointed out in our industry experts interviews, discussing the paradox of why end users would want to start using alternative platforms when they already have brilliant services at no cost through the platform they use today. They argue that the payment network in a country like Norway already has many of the features offered by a blockchain. It is fairly cheap for the end customer, and it has a high level of systematic trust. We therefore believe that a solution being able to threaten the existing payment network will come from an alternative network, having some kind of feature that does not exist in the existing network. When looking at the Norwegian payments market, we believe such features will be hard to find in the alternative payment service in itself, but will have to be in the surrounding ecosystem provided by the alternative value network.

9.1.3 LANG: A hierarchical approach to value networks within banking

As discussed so far in our analysis, there are different value networks within the banking industry, with different causal reasons for what defines the value network. Based on this, we will introduce a simple framework illustrating how value networks works differently depending on where in the industry hierarchy they are located.

We have named the framework LANG, an abbreviation of the levels in the hierarchy where we see the different value networks appearing. Local, Alliance, National, and Global. The framework helps to explain how banks look differently at new technology adoption based on geography, network effects, and cross functionality.



The local banks' customers expect high customer service, by helping each individual based on their personal needs. This implies that the local bank is expected to provide the end customer access to extended value networks by having partners within i.e. insurance and real estate broking. However, from a business processes perspective on the local level, such communication is often handled informal based on relations, with a varying degree of complex technicality underneath. Although trust is an important factor in such relations, we find it quite overkill for a local bank to introduce blockchain technology as a platform to provide these value network services to their end customers. Neither we believe it expedient to introduce a private blockchain for handling the interaction between the local bank and its partners.

On the alliance level we see constellations of local banks joining efforts to compete with big national banks and global actors. The complexity of having several autonomous banks being able to compete as one addresses the need for efficient trust and governance mechanisms. Earlier we have mentioned loan syndication as one of the processes where several of the advantages of blockchain technology can be leveraged. We also see that alliance banks recognize the economy of scale in cooperating in capital intensive parts of their offerings, such as insurance and a common nominee structure for holding a variety of assets. These are typically processes where we can see potential for an alliance of banks joining efforts on a private blockchain. Smart contracts on the blockchain can be used to handle the internal governance between the banks, enabling them to join financial muscles in the market while at the same time remaining independent. A big advantage is that a private blockchain is easier to do changes to since the closed environment controls the stakeholders and thus the governance mechanisms. As such, a closed alliance can to a large extent agree on their own private standards - as long as the system fulfills its purpose for the functional areas it serves and the need for interaction outside the alliance is fairly low.

A good example where these criteria were not met is the launch of Snapcash as a payment service in the Eika Alliance. The service was *private* - only for customers within the alliance - and although it was launched quite early, it was quickly sidelined when DNB launched Vipps and rapidly made it the defacto standard in Norway. What Vipps offered was simply communication with all banks, illustrating an example of a value network at the national level of the hierarchy. Another example of value networks on a national level can be established standards for electronic communication between financial and governmental institutions.

The closer a value network gets to a global level, we will argue that a) services offering access to the value network need to be functionally specialized and simple to use, and b) established standards need to be quite general. The causal reasons behind our arguing is for both scalability. In order to reach a large audience quickly, a service needs to perform one task very well and very simple. Relevant examples are different social networks, foreign exchange services (some based on blockchain technology), and peer-to-peer payment services. Because of different laws and regulations between countries, standards need to be on such a level that they can comply for everyone. This introduces a challenge in situations where there are already different established national standards, and there is a cost with transitioning to the common global standard. For global standards to succeed, we find it extremely important with broad involvement in order to establish agreements on common standards and a strategy for achieving them. Such processes are very complex and difficult to realize, but when realized they definitely threat established national standards. To exemplify this, we believe it very difficult for Vipps to survive if a common global standard for peer-to-peer payments is introduced. However, we believe a more likely scenario to be that the Nordic banks agree on a common platform based on the standards already established in the different countries. If a national or Nordic standard is to be threatened by a global alternative service, we believe that this must be a service as described in a), a service offering access to an alternative value network, and that is functionally specialized and simple to use. A concrete example could be Facebook or Apple offering peer-to-peer payment services enabled from a platform “everyone” already are using for day to day tasks and social interaction.

Placing a value network in the LANG hierarchy is not necessarily an easy task, as the levels will sometimes float into each other. An example is established national standards, where we often see common will to standardize further on either Nordic, European or global level. We have chosen to keep the model simple, but it is important to understand the spectrum between the national and global level although it is not illustrated in the framework.

As discussed, we believe the potential of blockchain to be different on the various value network levels. While we consider it to be very low on a local level, we see a big potential the closer to a global level one gets - given that the technology is appropriate for the services it is used for. On an alliance level we find it especially interesting, since this opens a great opportunity for private blockchains to handle complex governance through smart contracts, without having to fear that the technology ends up being on the "wrong" standard.

Following is a summary of how we view value networks on the different levels of the LANG hierarchy, and the potential for blockchain as an alternative value network platform for the different levels:

Level	Value network characteristics	Blockchain potential
Local	● Based on the services the local bank facilitates through relations	● Low potential due to relations to a large extent being personal
Alliance	● Closed systems within the alliance enabling the companies to deliver joint services while remaining independent players	● Good potential for private blockchains ● A big advantage that a private blockchain may continue to live as long as it has low need for external interaction, and that private blockchains are easier to change over time
National	● Services where there is a market need for a national standard ● Services where big actors define national standards for interaction (i.e. between banks and	● Good potential for services where the key attributes of the blockchain offers advantages over alternative technologies

	government)	
Global	● Functional specialized services that are easy to use and scalable, offering access to alternative value networks ● General defined standards aimed to comply all over the world	● Good potential for services where the key attributes of the blockchain offers advantages over alternative technologies

9.2 The emergence of dominant designs within Blockchain

We will apply Murmann & Frenken's framework, and start by scoping the discussion through defining what we mean by dominant designs in this context, before we use our LANG framework to decide the granularity level of our analysis. When discussing the temporal sequencing of the technology we will complement our analysis using industry dynamics theory, to give a perspective on where the technology can be placed in its life cycle, and what we can expect to see in the future based on a generic view. Then we will move into the core of the analysis: discussing causal mechanisms and reasons for why a dominant design may emerge on the granularity levels we analyze. Finally, we will complement the analysis with our perspective on relevant boundary conditions.

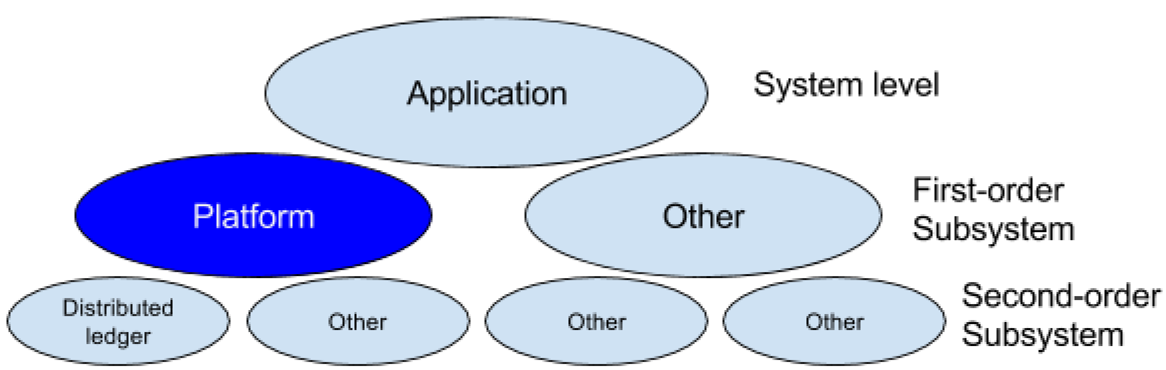
9.2.1 Definitions of dominant designs

Murmann and Frenken (2006) state that "a dominant design exists in a technological class when the majority of designs have the same technologies for the high-pleiotropy core components". We will scope our discussion around blockchain platforms, meaning platforms where blockchain applications can be built on top. A parallel easy to relate to is operating systems, where we see Microsoft Windows having emerged as a dominant design for PC operating systems, dictating certain prerequisites for application development in order to reach a large audience. This parallel also illustrates that dominant designs from a user perspective can coexist, where Apple iOS is similarly the dominant design for Mac computers.

Mougayar (2015) points out that currently, there are developers writing their app services to be blockchain-agnostic, with the expectancy that some blockchains will die while others will survive. He further describes why blockchains have the ability to “go way beyond a one-currency type of scenario”, hence emerge into different dominant designs for different application areas, ie. money, value, governance, contracts, ownership, trust, assets, etc. He emphasizes that it is too early to tell how the landscape will develop, and draws a potential scenario that it may end like social media, with a couple of giant platforms and millions if not billions of end-users.

9.2.2 Unit of analysis

As stated earlier, our analysis will be performed from the platform level of the blockchain system hierarchy. Ethereum and Bitcoin are examples of such platforms, where applications can be built on top of the platform. In this perspective, the platform can be viewed as a “First-order Subsystem” according to Murmann & Frenken’s definitions, and blockchain or distributed ledger technology as the “Second-order Subsystem”. On the different levels of the system hierarchy, there are also other subsystems (for example user interface on the platform level), altogether defining the application at the top “System Level” where the Decentralized apps (Dapps) are located.



Through our expert interviews, some of the criticism of blockchain was directly related to the blockchain technology itself, and that other distributed ledger technologies might be developed addressing the same problems in a better way than blockchain. By analyzing the potential for a dominant design on the platform level we bypass some of this criticism, since the underlying distributed ledger technology - whether it is blockchain or something similar - is less interesting. We can draw the analogy back to Windows as a dominant design for PC operating systems: The operating system as a platform can emerge as a dominant design even though the underlying technology may be criticized for lack of standardization, failure to meet requirements and hardware failures. Under the assumption that the underlying distributed ledger technology will continue to gradually develop addressing its current flaws, we wish to analyze and understand the potential for dominant designs on its platform level.

9.2.3 Granularity of analysis

Different blockchain platforms are emerging for different markets, businesses and end user needs, i.e. cryptocurrencies as a substitute for traditional currency and smart contracts as a concept for avoiding the cost of third parties when making agreements. Currently, we see that certain platforms are more dominant than others within their use areas - for instance is Bitcoin the most popular platform for cryptocurrencies while Ethereum has gained ground for smart contracts. Since dominant designs can emerge in different dimensions, Murmann & Frenken state the importance of narrowing the scope by specifying the granularity of the analysis.

We will tie our analysis to how we see the relevant value networks within the industry. More specific, we wish to examine the potential for dominant designs on the LANG levels deducted through our value network analysis:

- Blockchain platforms for local use (L)
- Blockchain platforms for alliances (A)
- Blockchain platforms for national networks (N)
- Blockchain platforms for global networks (G)

Our chosen granularity level implies that we choose to focus less on usage area and more on how causal mechanisms across the industry value networks influence what becomes the dominant platform for that certain network level. One granularity level finer would also include a certain usage area, while one level coarser would be to aggregate the different levels into one group.

9.2.4 Temporal sequencing

Abernathy and Utterback (1978) and Suarez and Utterback (1995) suggest that dominant designs emerge once in the evolution of a particular product class, and that they continue to exist for as long as the product class continues to find customers in the market. Others again argue that the evolution of product classes is marked by recurring technological discontinuities followed by the emergence of a new dominant design (Murmann & Frenken, 2006).

Murmann & Frenken describe the emergence of dominant designs as a cyclical process marked by a technological discontinuity, an era of ferment (variation), the selection of a dominant design, and an era of incremental innovation (retention) broken once again by a technological discontinuity (Murmann & Frenken, 2006). We believe that there may be a potential within distributed ledger technology for creating a technological discontinuity for traditional centralized ledger technology, due to its advantages in terms of cost, time and security. We would argue that we currently find ourselves in the era of ferment, with a lot of undergoing experimentation on the technology. If a dominant design emerges, we will be likely to see an era of innovation, where the technology gradually replaces older technology used to perform the same tasks. Because technological discontinuities have competence destroying effects on incumbent firms, it potentially lowers the barriers to entry for new firms (Anderson & Tushman, 1990).

In our interview with Prof. Utterback (Utterback 2016), he stated that the history of dominant designs shows us that we do not know what will become the dominant design and where we will see its emergence until it is there - fully emerged as a dominant design that the market players adhere to. Due to the blockchain technology's yet short existence we cannot say which product markets we will see a dominant blockchain platform emerge - and certainly not which platform will become the dominant one. We will instead use theory about industry dynamics to draw a picture of how a potential market where blockchain technology replaces an existing technology can look like, and use this to describe where we see the technology now and how we can expect such a market to develop.

We believe that the market for blockchain platforms is still in an early phase (phase 1 in the model), indicated by rapid changes, lots of new entrants continuously introducing new platforms building on the technology, and no clear indications that incumbents have exited because of the new technology. We neither have solid proof that the technology will actually manage to revolutionize the market, nor which exact technologies it will manage to replace. While blockchain technology may fail on some areas, it can become successful on others. Under the assumption that a market where blockchain technology will gain terrain will follow Agarwal & Gort's path, we can use the model to draw some generic conclusions on how we expect such a market to develop as the technology development advances.

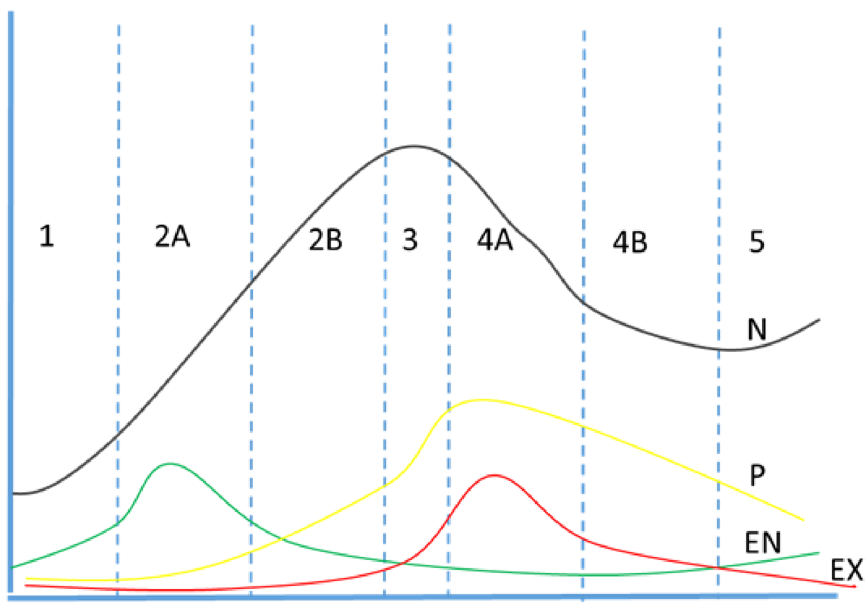


Figure – Entry, Exit and Number of Firms Across Satges
Addition to orginal figure the muber of patents (yellow)

The gross number of entrants (EN) start to slow as a new market establishes (2A). Gross numbers of firms (N) rise sharply in stage two due to a high number of gross entrants, mainly due to the fact that there is not yet a large number of incumbent firms to exit the market (EX). The rate of technical change peaks in both stage 2 and 4 (Gort & Klepper, 1982b), the difference in the two stages being that in stage 2 the majority of innovations emerge from inventors external to the incumbent firms. Also, the innovations are more likely to be fundamental innovations towards the market in stage 2, whereas innovations that tend to be more incremental innovations or pure product refinements are observed in stage 4 (Agarwal; Gort 1996).

New entrants having innovations not being available to incumbent firms, will make the barriers for market entry low, which is coherent to what we observe in phase 1 and 2. The rise of exits in stage 4 can be explained by the fact that it is harder to imitate technologies, making the barriers to entry higher, thus giving advantages to incumbent firms. Number of patents are also shown to rise and to peak in stage 4 (Agarwal, 1994).

9.2.5 Causal mechanisms

Underlying causal logics to explain why one particular design approach rather than another emerges as the dominant design can be classified into five types (Murmann & Frenken, 2006):

1. The dominant design represents the ***best technological compromise***, forcing other players to imitate the design to win customers.
2. ***Economies of scale*** that can be realized with standardized products. The design that initially acquires a lead in market share will emerge as the dominant design, and the design emerges a consequence of a first mover advantage.
3. ***Network externalities*** in a situation where the value of adopting a particular technology depends on the number of users who have purchased a compatible technology.

4. ***Strategic maneuvering***, including coalitions, R&D collaborations, pricing, and licensing. In this view a dominant design is treated more as consequence than a cause.
5. ***Combination of sociological, political, and organizational dynamics***. Dominant designs emerge through negotiations involving a diverse set of actors with a stake in the technology.

Where we find it relevant, we will link the analysis to the value network analysis and the LANG hierarchy. For each part of the analysis, we will wrap up our key takeaways consecutively.

Best technological compromise

In our interview with Prof. Utterback (Utterback 2016), he stated the importance of understanding what features of a product or technology that are really the crucial ones. This can probably be seen as a first step towards understanding what makes the best technological compromise. In our value networks analysis we went through the example of the payments value network in Norway, where more than 100 independent or alliance connected banks on the Norwegian market gave up their own payment apps and consolidated around DNB's Vipps platform (Hoemsnes, 2017). There can be many different strategic reasons behind such an effort, but one very important is that Vipps was the first "bank agnostic" platform, meaning that the customer could use the app for payments within the Norwegian market, no matter what bank he or she was connected through. This in contrast to for example Eika's Snapcash app - by many seen as a better technology, but from a customer perspective a far worse service since it only worked for transfers between customers of one of the Eika alliance banks. Although it is too early to state Vipps as the dominant design for mobile payment apps in the Norwegian market, we can at least say that it has taken a big step in order to become so. The new Vipps coalition lifts payment platforms from being local and alliance specific into a common effort of creating a national standard.

Relating this to our value network analysis, we believe that reaching a technological compromise increases in importance as the platform moves from being a local towards becoming a global solution. What will happen to Vipps when global actors like Facebook, Apple and Samsung enters the Norwegian markets with their mobile wallets? How long will it take before the users no longer accepts the boundaries caused by a national limited platform, and move their mobile payment activities to one of the global platforms? We believe the same questions to be relevant for blockchain platforms, and that the Vipps analogy can teach us the importance of the relation between technological features, the end users, and their practical day-to-day needs, a combined factor we believe to be crucial in the emergence of a dominant blockchain platform.

Key takeaways:

- *End user needs can force competitors to agree on a technological compromise.*
- *A technological compromise on a common platform on a lower level in the LANG hierarchy will always be subject of threat from platforms coming from a higher level in the hierarchy.*

Economies of scale

Economies of scale correlate with the market size - as your output increase, your unit costs are reduced (Staff, 2003). For blockchain platforms, we believe that the importance of economies of scale will vary based on the audience and use area of the applications built on the platform. If the platform is used for transactions within a closed group of banks, we believe economies of scale to be of little importance. In contrary, if the platform is meant to provide an open-source solution available for everyone on a global level, like Bitcoin, we believe economies of scale to be of significant importance. In 2016, Bitcoin had a market capitalization of $14,590,356,108 while the runner-up, Ethereum, had a market capitalization of $638,041,577 (Reese, 2016). We would argue that Bitcoin has an advantage in terms of economies of scale through a large user base, making it difficult to launch a solution addressing the same market. This is what Mougayar (Mougayar, 2015) refers to as “Defensibility” - barriers to entry strengthened as the service grows valuable with each new user, also resulting in high switching costs. In context of our value network analysis, we can conclude that economies of scale becomes more relevant as causal mechanism for the emergence of dominant designs the higher in the LANG hierarchy the value network exists. Thus, we believe economies of scale can explain how global platforms create new value networks by introducing specialized services leveraging on their existing user base. An example is Facebook introducing peer-to-peer payments, a new service expanding their value network, convenient for customers already having the Facebook app on their smartphone.

Key takeaways:

- *Economies of scale correlates with market volume, and is a more relevant causal mechanism the higher in the LANG hierarchy a value network exists.*
- *Economies of scale incentivise global actors from other industries to create new value networks around specialized services in order to take a part of a new market leveraging on their existing user base.*

Network externalities

Network externalities is the effect that one user of a good or service can have on the value of that product to others. When a network effect is present, the value of a product or service is dependent on the number of others using it. Thus making it closely connected to economies of scale, and also often referred to as the demand side of economies of scale (Carl Shapiro, 1999).

Mougayar (2015) evaluates Bitcoin network externalities which we also find applicable for blockchain in general. He summarizes the analysis into the following areas:

- Inter-connectivity: Must exist between groups or systems inside the network.

- User experience: Must be unique, original, and enable some new value creation while users are on the service.
- Defensibility: Barriers to entry strengthened as the service grows valuable with each new user, also resulting in high switching costs.
- Currency liquidity, including stability and low volatility.
- Consensus engine, including the underlying protocols that govern it or support it.
- Blockchain platform services, including the software tools and external linkage capabilities.
- End-user applications, including wallets, special browsers, smart contracts, pegged services, or being part of DAO.
- Number of apps or services, and number of developers and users on these apps

On higher levels of the LANG hierarchy we believe network externalities to be tightly connected to economies of scale. Global platforms with large user bases are able to leverage on the concept of network externalities by expanding their value network with new services, in order to achieve economies of scale on their user base.

What we find especially interesting is that despite the close connection between economies of scale and network externalities on higher levels of the LANG hierarchy, the latter reveals causal mechanisms also applicable for value networks on the lower levels. A practical example can be a blockchain for real estate transactions. The main purpose of such a blockchain is to ensure a smooth transaction in terms of transferring the money to the seller and the real estate to the buyer. This requires the blockchain platform to be able to establish smart contracts between the real estate agency, the buyer's bank, the seller's bank and public authorities. Whether or not the platform can reach a large end user audience is of less importance.

Key takeaways:

- *Network externalities are on a higher level of the LANG hierarchy tightly connected to economies of scale, where global platforms leverage them to create new value networks in order to achieve economies of scale.*
- *On lower levels of the LANG hierarchy, we believe network externalities to be especially important for blockchain platforms when it comes to smart contracts.*

Strategic maneuvering

In the view of strategic maneuvering, a dominant design is treated more as a consequence than a cause, and for the financial industry we see clear indications that a common standard may become defined as a consequence of collaboration within the industry. Financial institutions from all over the world organized through the R3 consortium are working on a common ground for a blockchain-based solution to improve the financial services infrastructure (Maras, 2016). This initiative, where institutions actively seek a common platform, can be seen as a strategic maneuvering where the dominant design emerges as a consequence, because the institutions understand that each working on their own will not persist a sustainable model.

This is also what we see in Norway with the mentioned collaboration between banks on the Vipps payments platform. These cases demonstrate that competitors get incentives to collaborate when they understand that they have more to gain on agreeing on a common standard from within the industry than being disrupted from the outside.

An interesting question rises when a dominant design emerged as consequence of strategic maneuvering on a higher level collides with a dominant design emerged as consequence of strategic maneuvering on a lower level. We don’t necessarily believe it to be given that the dominant design coming from a higher level of the hierarchy will always win, for example if the players in the lower level market is true to the established standard and the value network the standard serves is performing well. We therefore believe that dominant designs due to the strength of collaborative forces can very well vary on the different levels of the LANG hierarchy.

Key takeaways:

- *Strategic maneuvering is relevant on all levels of the LANG hierarchy.*
- *Dominant designs introduced through strategic maneuvering on a lower level of the LANG hierarchy will always be threatened by a different design coming from a higher level.*
- *An important incentive for strategic maneuvering is to protect the market from outside attackers. Since the standard emerges as a result of common interests in the market, a dominant design on a lower level can stand strong and resist the threat from a higher level standard.*

Combination of sociological, political, and organizational dynamics

It is not given that the R3 consortium will define the standard for what eventually becomes the dominant blockchain platform design within the financial industry. R3's reasoning behind the collaboration is to take the lead for deciding the industry standard before someone else do it from outside the industry. Because of complex regulatory and technical surroundings, the financial industry needs to cooperate both internally in the industry and with other stakeholders in order to be able to take advantage of the technology on a future-oriented working platform. However, the industry may not - and in our opinion will not - succeed defending from intruders from other industries.

Maras and Mougayar (Maras, 2016; Mougayar, 2015) warns about creating another "Android vs. iOS situation" within blockchain platforms, where the chasm between operating systems, apps, and app stores becomes the industry's Achilles' heel. We believe this to be a plausible scenario. While the industry will fight for one common standard through the R3 consortium, there may emerge one or more alternatives from the outside, from actors with interest in challenging the old industry silo paradigms and open up for cross-industry platforms and solutions.

In such a scenario, we will probably see a new way of providing and bundling financial services, disrupting today's industry standards. Global wallets from actors as Samsung, Apple and Facebook, established from outside the traditional financial industry, are again good examples. New regulations like PSD2 will allow these and other entrants to access information about the bank's customers, enabling them to use existing industry data while building new platforms to combine this data with other data. Recently, Capgemini launched an open banking platform for PSD2 on blockchain (Capgemini 2017), illustrating blockchain technology as an enabler in order to build a financial services platform on the side of the existing industry, combining existing industry data with data from other industries, and bundling this into new insights and new services.

Key takeaways:

- *While the industry will collaborate on creating a common platform standard, we believe the incentives for actors outside the industry to be so strong that this standard will not stand alone.*
- *Regulations are introduced to increase competition within the industry, again making it even more difficult for incumbents to shut out intruders.*
- *The blockchain has attributes for providing industry data through open interfaces enabled by regulations like PSD2, opening up for actors from outside the industry to innovate on existing industry information and data.*

9.2.6 Boundary conditions

Initially, theories about dominant designs were about addressing physical attributes of a product or technology becoming a de facto standard, and being able to explain the emergence of such standards by looking in the rearview mirror. In such traditional views on dominant designs, a technology like blockchain can not be discussed in terms of dominant design, due to limitations in what the researchers see as relevant boundaries for such a phenomenon to occur.

When discussing the limitations of our analysis, it is therefore reasonable to address whether dominant design theory can be applied as broad as we do here, trying to forecast the future of a rather abstract non-physical concept. Modern views on dominant design theories support extending the concept to non-physical artifacts. Murmann and Frenken (2006) argue that the concept can be applied to virtually all artifacts, and present their framework as applicable for complex artifacts, where they describe the complexity to be caused by numerous relevant design dimensions that interact in complex and unpredictable ways.

An important prerequisite to address is where we in our unit of analysis discussion conclude that analyzing the platform level makes our analysis independent from whether we discuss blockchain as a specific technology or distributed ledger technologies in general. Since Murmann & Frenken's approach is based on a definition that dominant design exists in a technological class when the majority of designs have the *same technologies for the high-pleiotropy core components*, the question becomes if one can argue that treating these two concepts as one meets this definition. Throughout the thesis we have argued for this, although finding it relevant to address.

We believe that our analysis shows a clear potential for dominant designs occurring within blockchain technology. However, it does not give a clear view on where we will see them emerging, or even if we will see it happen. Even though, the analysis helps us understand *where* standards potentially may emerge, reasons for *why* it may happen, *how* it may occur, and enable us to understand *when* it is happening. This is useful for players in relevant value networks in order to understand the dynamics of the business they operate in.

9.2.7 Generic strategic guidelines based on dominant design theory

Murmann and Frenken (2006) conclude a set of key findings based on a firm's position in the system hierarchy discussed in our unit of analysis analysis, that can be translated into strategic guidelines for the assumption that dominant designs will emerge within certain areas of blockchain for the financial services industry.

Industrial dynamics at the different system hierarchical levels differ, and higher-order design developments, especially standardization, greatly affect industrial dynamics at lower levels. Standardization may trigger entry at a lower subsystem level while forcing firms to exit at the system level. If for example one cryptocurrency crystallizes itself as the standard cryptocurrency, this may trigger entries on lower levels supporting the standardized cryptocurrency, while at the same time forcing exits among other cryptocurrencies at the system level and also application level of the exiting platforms.

Murmann and Frenken conclude that firms producing components with high pleiotropy at lower levels have greater influence on bringing about dominant designs. This is consistent with our analysis, that dominant designs within blockchain are likely to happen on the platform level rather than the application level or underlying technology level. Further, Murmann and Frenken expect firms that produce components with high pleiotropy to be more successful over time than firms producing components with a lower pleiotropy. They explain this with the knowledge and resources characterizing these firms are more complex and less easy to imitate than for others.

Finally, they expect the effects of radical innovations in a particular subsystem to be more negative on firms that assemble the particular subsystem than on firms that are higher-level assemblers. Following, that firms higher up the hierarchy have a greater control over their life course than those at lower levels of the hierarchy. Translated; in early stages, where there is big uncertainties about the future of underlying subsystems and components of a system, it is safer the higher up the system hierarchy you are. This seems like a plausible conclusion in some cases, but we believe it is more nuanced, for one thing depending on the top system level complexity and on the other hand the balance between the components in the lower subsystems. For a system with low top level complexity it is probably easier to adapt the system to changes in underlying subsystems than for systems with high top level complexity. Also, while a blockchain application indeed will consist of different subsystems, in many cases the underlying platform will be such a dominating subsystem that we believe it is of less importance what level of the hierarchy you are if a radical innovation in the underlying technology occurs.

In view of our recent discussions, these generic strategies can be shaped into the following recommendations for financial services institutions with regards to their strategic positioning when it comes to blockchain technology:

1. Even though we don’t believe it to be the only standard, we find it plausible that the financial services industry will find a common ground on a blockchain platform adapted to the needs of the industry. Larger institutions should take an active role in contributing to defining this standard through the R3 consortium, while smaller players should follow the development closely - understanding the consequences for themselves.
2. The big institutions should focus on establishing a dominant design on the platform level, as this creates first-mover advantages within the to-be established standards, while also building foundation for reductions in costs and risks.
3. Small institutions and startups should focus on innovating on the application level. They need to ensure avoiding complexity that potentially may force them to exit when radical changes in underlying platforms on a subsystem level potentially occur.

10 Conclusions

Our analysis concludes that it is not very likely that one common standard for blockchain platforms will emerge - we believe there is too big differences among the value networks the technology can serve, and end user needs between the different value networks. We believe a more likely scenario to be different standards emerging for different use areas, serving specific value networks aimed at specific user groups.

As presented in our value networks analysis, we believe blockchain technology to have more potential the closer to global level in the LANG hierarchy a value network exists. On local level we believe the potential to be low, while we see a very interesting potential for private blockchains to be used within alliances in order to enhance internal efficiency and operating as one combined force in the market.

The granularity scoping of our dominant design analysis opens up for the underlying distributed ledger or blockchain technology to continue to develop to address current flaws. Indirectly, it also follows by the analysis that a standard can occur on platform level even today as long as the underlying technology has the right attributed to address the problems the Dapps on the platform aims to handle.

For financial services in specific, there will probably continue to emerge new platforms for different parts of the industry value network and for different use areas. However, we believe there is a potential for converging to certain standards on the different domains. We believe strategic maneuvering and network externalities to be causal mechanisms forcing the traditional financial industry to align themselves on one common industry standard for how to address blockchain within today's core industry processes, where the R3 consortium initiative seems likely to land on one such standard.

However, we believe that opportunities exposed by the technology for outside actors will naturally introduce platforms and applications from other industries. This can be entrants with interest in a piece of the financial industry cake, out of causal reasoning based on economies of scale and network externalities, combined with the deregulation of the financial industry partly driven by the PSD2 directive. We believe that more digitally savvy end users will push the industry innovation forward, demanding new value networks opening up for wider network externalities than traditionally. An example can be global social networks seeing the opportunity in entering specific domains within the financial industries, like for instance direct payments, capitalizing on their large user base and possibility to bundle financial services with new information and services. These players will have strong incentives for supporting alternatives to the R3 platform if they decide to address some of their services through blockchain technology.

We may also see standards emerging on national levels, for example for public real estate records. The causal reasoning behind this can be network externalities - the need for increased efficiency between governmental institutions and private actors from different industries, where blockchain technology can become a catalyzer for such.

Finally, we also find it reasonable to believe that there is a potential for standards converging for specific use areas where the technology has proven to work well, and where there are few reasons why there should exist different platforms and applications doing the exact same thing. An obvious example is cryptocurrencies. However - as long as flaws with existing technology and platforms are addressed, new alternatives will continue to emerge in order to address the flaws through technology improvements.

We believe blockchain technology to play an important role in the future of financial services - either for enhancement of current processes, as a tool for efficient communication with outside the industry, or as an opportunity to disrupt the industry from the outside. The technology is still in an early phase, and will probably continue to evolve from how we know it today. However, the concept of distributed ledger has proven powerful and has the potential to disrupt the traditional financial services industry from how we know it today.

Incumbents can either take an active role in contributing in the development of industry and national standards, or take on a more passive role, adjusting to the standards decided by others. This is probably the “easy” question, to a big extent given by the size of the incumbent and its ability to influence such decisions. However, the question only addresses how the industry as a whole must act to protect itself from outside attackers. The tricky question is how each and every company should respond on an individual level, summing up to whether you want to become one of the industry defendants or whether you want to take a position as an attacker from the inside of the industry. We have not addressed this in our thesis, but very much like to see it addressed through further studies.

Independent of strategy, incumbents in the financial industry in our opinion need to have a clear understanding of blockchain technology, what opportunities it exposes for incumbents and entrants, across industries, and in the interface between private corporations and public institutions.

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